Amendments to the Specification:

Please replace paragraph **[0008]** with the following amended paragraph:

[0008] In other embodiments, the magnetic element may be a curved shape which stores a corresponding curved magnetic field in response to write signals on a correspondingly curved write line.

Please replace paragraph **[0010]** with the following amended paragraph:

[0010] In another aspect, the present invention provides a memory cell comprising: a magnetic element having a first segment, a second segment and a third segment for storing first, second and third remnant magnetic fields in response to a write signal, wherein each of the first, second and third remnant magnetic fields may have a first direction or a second direction, and wherein when said first, second and third remnant magnetic fields are in said first direction the memory cell is in a first orientation, and wherein when said first, second and third remnant magnetic fields are in said second direction the memory cell is in a second orientation; a write line for applying said write signal to said magnetic element; and a sensor for detecting the orientation of the memory cell.

Please replace paragraph **[0020]** with the following amended paragraph:

[0020] It is necessary to electrically isolate magnetic element ~~24~~ 26 from sensor 24. A metal layer 27 (not shown in Figures 1 and 2) is formed between sensor 24 and magnetic element 26. Metal layer 27 is used as a bonding layer for attaching magnetic element 26 to substrate 22. In cell 20, metal layer 27 is formed of a titanium layer (formed first on substrate ~~20~~ 22 adjacent to sensor 24) and a gold layer (formed on top of the titanium layer). At the interface between sensor 24 and the titanium layer of metal layer 27, a Schottky diode is formed that prevents the flow of electrical energy

from sensor 24 to magnetic element 26, under zero or reverse bias conditions between magnetic element 26 and substrate 22. In an alternative embodiment of the present invention, the metal layer may be formed of only a titanium layer, or may be formed using a different metal.

Please replace paragraph **[0024]** with the following amended paragraph:

[0024] Referring also to Figure~~,~~ 4, segments 34, 36 and 38 together define a middle region 39. Each of segments 34, 36 and 38 has an inner side and an outer side. The inner sides 34i, 36i and 38i of the three segments are adjacent to region 39. The outer side 34o, 36o and 38o are on the opposite sides of segments 34, 36 and 38. Middle region 39 is generally aligned with sensing region 25 of sensor 24.

Please replace paragraph **[0028]** with the following amended paragraph:

[0028] Segment 34 of magnetic element 26 is responsive to magnetic field 62 and acquires a magnetic field 66. When the write signal 72 is removed, ~~element~~ segment 34 remains magnetized with magnetic field 66 (which will have smaller magnitude than when the write signal 72 is being applied). That is, magnetic field 66 remains in segment 34 as a remnant magnetic field.

Please replace paragraph **[0030]** with the following amended paragraph:

[0030] In cell 20, write line ~~20~~ 28 is wider than segments 34, 36 and 38 in the directions identified by arrows 52, 56 and 58. This relationship is desirable ~~to~~ so that the magnetic field 62, for example, around segment 44 passes through segment 34 substantially ~~in the direction~~ in the direction 62 in which segment 34 is to be magnetized. In other embodiments, each segment of write line 28 is at least as wide as an associated segment of magnetic element 26.

Please replace paragraph **[0037]** with the following amended paragraph:

[0037] The use of sensor 24 to detect the orientation of cell 20 will now be described. Reference is made to Figures 9 and 10. Figure ~~8~~ 9 illustrates the magnetic element 26 and sensor 24 of cell 20. Figure ~~9~~ 10 is a sectional view of cell 20 taken along the same section line as Figure 3. The shading of sectioned elements has been omitted for clarity in the drawing.

Please replace paragraph **[0043]** with the following amended paragraph:

[0043] In cell 20, sensor 24 is a Hall effect sensor. The operation of a Hall effect sensor is well known and may be described here briefly. A sensor current ~~116~~ 136 is applied across current application line 30. The flow of sensor current ~~116~~ 136 through sensing region 25 is affected by the magnetic flux fields created by magnetic fields 66, 68 and 70, effectively changing the direction of free carriers flowing as part of sensor current ~~116~~ 136. These flux fields have a cumulative effect on the sensor current ~~116~~ 136, since they pass through the sensing region in the same vertical direction. The change in the direction of the free carriers in sensing region 25 creates a charge separation that can be sensed at terminals ~~140~~ 120, ~~142~~ 122 as a potential gradient, commonly referred to as the Hall voltage. The magnitude of the Hall voltage will correspond to the total vertical components of the magnetic flux lines passing through sensing region 25.

Please replace paragraph **[0044]** with the following amended paragraph:

[0044] If the orientation of cell 20 is reversed so that segments 34, 36 and 38 store magnetic field 94, 92 and 90, then the flux fields around segments 34, 36 and 38 will have the opposite direction - the directions of flux lines 100 - 112 will be reversed. The vertical components of flux lines 100 – 112 will pass through sensing region 25

from top to bottom and the Hall voltage measured across terminals ~~140~~ <u>120</u>, ~~142~~ <u>122</u> will have an opposite polarity.

Please replace paragraph **[0045]** with the following amended paragraph:

[0045] In this way, the orientation of cell 20 may be determined by measuring the polarity of the Hall voltage across terminals ~~140~~ <u>120</u>, ~~142~~ <u>122</u>. The use of a Hall sensor allows the orientation of cell 20 to be determined in a non-destructive way – i.e. the orientation of cell 20 is not destroyed or changed by the sensing process.

Please replace paragraph **[0046]** with the following amended paragraph:

[0046] Segments 34, 36 and 38 are positioned on three sides of sensing region 25. The multi-segment configuration of magnetic element ~~24~~ <u>26</u> allows the magnetic flux fields created by the magnetic fields stored in all three segments 34, 36 and 38 to simultaneously affect the flow of free carriers in sensor current ~~116~~ <u>136</u>. The effect of the three magnetic fields is cumulative, thereby creating a larger overall vertical component for the flux field passing through sensing region 25 than would be created by a magnetic element with only a single linear element.

Please replace paragraph **[0048]** with the following amended paragraph:

[0048] Typically, the application of sensor current ~~116~~ <u>136</u> through current application line 30 and the sensing of the Hall voltage at terminal<u>s</u> 120, 122 will be performed by a microprocessor or micro-controller or other control device (which will typically be the same device that controls the storage of data in the memory cell). In order to apply sensor current ~~116~~ <u>136</u> and measure the Hall voltage, it is necessary to couple electrical circuitry to current application line 30 and voltage sensing line 32. To facilitate this, sensor 24 has been illustrated in the Figures at a 45° angle from the sides of magnetic element 26. The present invention is not limited to this angle, and in fact the angle is not required at all – sensor 24 may be oriented in the same horizontal and

vertical directions as magnetic element 26 and write line 28, as long as its current application line 30 and voltage sensing line 32 are accessible.

Please replace paragraph **[0049]** with the following amended paragraph:

[0049] As noted above, in cell 20, sensor 24 and magnetic element 26 are not separated by an insulating layer but are instead electrically insulated by a Schottky diode formed between metal layer ~~25~~ 27 and sensor 24. The absence of an insulating layer allows the magnetic element 26 to be positioned closer to sensor 24. This results in a stronger magnetic flux field (from each of the magnetic fields stored in segments 34, 36 and 38) passing through sensing region 25. This also allows a less sensitive Hall sensor to be used.

Please replace paragraph **[0052]** with the following amended paragraph:

[0052] Figure 11 illustrates a second embodiment of a memory cell 220 according to the present invention. Memory cell 220 has a substrate (not shown), a sensor 224 formed in substrate, three separate magnetic elements 226a, 226b and 226c and a write line 228. Magnetic elements 226a, 226b and ~~226b~~ 226c are generally rectangular. One segment 244, 246 or 248 of write line 228 is aligned with each of the magnetic elements. The three magnetic elements 226a, 226b and 226 c are responsive to write signals transmitted between terminals 240 and 242 of write line 228 to store remnant magnetic fields in their hard directions of magnetization 252, 256 and ~~258~~ 260. Like segments 34, 36 and 38 of magnetic element 26 (Figure 1), the magnetic fields may have their south poles towards the sensing region 225 of sensor 224 in a first orientation or may have their north poles towards sensing region 225 in a second orientation. The orientation of cell 220 may be sensed using sensor 224 in the same way as sensor 24 of cell 20 (Figure 1).

Please replace paragraph **[0053]** with the following amended paragraph:

[0053] Figure 12 illustrates a third embodiment of a memory cell 320 according to the present invention. Memory cell 320 is similar to memory cell 220 (Figure 11),

except that magnetic elements 326a, 326b and 326c are not rectangular. Instead, 326a, 326b and 326c approximate the shape of magnetic element 26, with a gap at corner regions 321a and 321b. Write line 328 and sensor 324 are used in the same way as write line 28 and sensor 24 to write data to cell 320 and to sense the data stored in cell 320.

Please replace paragraph **[0055]** with the following amended paragraph:

[0055] ~~signal~~ Figure 14 illustrates a fifth embodiment of a memory cell 520 according the present invention. Memory cell 520 differs from memory cell 420 in that magnetic element 426b has been removed. Otherwise, memory cell 520 operates in the same manner as memory cell 420.

Please replace paragraph **[0057]** with the following amended paragraph:

[0057] Figure ~~15~~ <u>16</u> illustrates a seventh embodiment of a memory cell 720 according to the present invention. Memory cell 720 differs from memory cell 620 only by the addition of a sixth segment ~~638~~ 738 to magnetic element ~~626~~ 726. Otherwise, memory cell 720 operates in the same way as memory cell 620.

Please replace paragraph **[0060]** with the following amended paragraph:

[0060] Figure 18 illustrates a ninth embodiment of a memory cell 920 according to the present invention. Memory cell 920 has a semi-circular magnetic element 926. Write line 928 also has a semi-circular shape where it overlies magnetic element 926. Magnetic element 926 is ~~response~~ responsive to a write signal transmitted on write line 928 to store a remnant magnetic field. The magnetic field ~~960~~ has a shape corresponding to that of magnetic element 926. The poles of magnetic field are aligned

along the inner edge 926i and outer edge 926o of magnetic element 926. Accordingly, the magnetic field in any part of magnetic element 926 will be aligned radially, as

illustrated by lines 952a, 952b, 952c and 952d. The magnetic field at any part of magnetic element 926 will produce magnetic flux fields through sensing region 925 as generally indicated by arrows 962a and 962b. These magnetic flux fields will have cumulative components normal to the plane of sensing region 925 and these components may be measured using sensor 924 in the same manner as described above in relation to sensor 24.

Please replace paragraph **[0061]** with the following amended paragraph:

[0061] Figure 19 illustrates a tenth embodiment of a memory cell 1020 made according to the present invention. Memory cell 1020 has a magnetic element 1026 in the shape of ~~a~~ an open or incomplete toroid. Magnetic element 1026 ~~will~~ is operated in a similar manner as magnetic element 926 to store a curved remnant magnetic field, which in turn can be measured using sensor 1024 in the manner described above for sensor 24. Write line 1028 has a similar open toroid shape where it overlies magnetic element 1026. Magnetic element 1026 surrounds sensing region 1025 almost completely and accordingly will provide a substantial magnetic flux field through sensing region 1025. However, the extremely curved shape of write line 1028 may result in substantial inductance in write line 1028, slowing down the transmission of write signals on write line 1028 and possibly slowing the rate at which the orientation of a magnetic field stored in magnetic element 1026 may be reversed.

Please replace paragraph **[0064]** with the following amended paragraph:

[0064] Magnetic element 1126 is generally rectangular, with a trapezoidal section defined by sides 1134, 1136 and 1138 removed. Sides 1134, 1136 and 1138 are adjacent to and generally surround sensing region ~~1025~~ 1125. Write line 1128 is linear and has terminals 1140 and 1142. A write signal 1172 may be transmitted on write line

1128 from terminal 1140 to terminal 1142. Alternatively, a write signal 1174 may be transmitted from terminal 1142 to terminal 1140. Magnetic element ~~1142~~ 1126 will be magnetized by a write signal in either direction and will store a remnant magnetic field in the direction of line 1152. The particular orientation of the remnant magnetic field will depend on the direction of the write signal.

Please replace paragraph **[0065]** with the following amended paragraph:

[0065] A known property of ferromagnetic materials is that magnetic flux field lines typically exit the surface of such materials at an angle to the plane of the surface. Typically, the angle will be 45° or greater. The precise angle at which the magnetic flux lines will exit the surface will depend on the permeability gradient between magnetic material and the surrounding materials. If magnetic element 1126 has a remnant magnetic field as indicated by arrow 1166, then, as a result of this property, magnetic flux field lines will exit sides 1134, 1136 and 1138 of magnetic element generally in the direction of arrows 1162, 1163 and 1164. These magnetic flux field lines will pass through sensing region 1125. As in the case of the preceding embodiments, the magnetic flux field lines will have a cumulative component that is normal to the plane of sensing region ~~1025~~ 1125, allowing the orientation of the magnetic field 1166 to be sensed. If magnetic element 1126 has the opposite magnetic field stored in it due to a write signal 1174, magnetic flux lines will flow opposite to arrows 1162, 1163 and 1164 and this may be sensed using sensor 1125.